LUMISCAN LSDT SCSI COMPATIBILITY PROTOCOL SPECIFICATION

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Added support for LSDT Averaging mode, byte swap mode, and film present status.
New commands 0xA+0xC and 0xA+0xE, changed Inquiry response data.
Include the Internal SCSI Option; added CCD type scanners.
Changed 50/75 into LSDT.

LSDT SCSI Compatibility Protocol Specification

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1.0 INTRODUCTION

1.1 Identification

This document specifies the Small Computer Systems Interface (SCSI) protocol used by the Lumisys LSDT family of Film Scanners. The protocol is known as the ***Lumiscan LSDT SCSI Compatibility Protocol.*** (Future revisions of this document will refer to this protocol as the ***LSDT Compatibility Protocol.)***

1.2 Purpose

This document is provided to host programmers to be used to develop an interface to communicate with the **LSDT** scanner family using a protocol which is similar to that used with previous Lumisys scanner products. The *Lumiscan LSDT SCSI Compatibility Protocol* provides some backward compatibility with the Lumiscan 100, Lumiscan 150, and Lumiscan 200 SCSI protocols.

1.3 Disclaimer

While the protocol documented herein is intended to reduce the software effort required to integrate LSDT scanners with applications designed to use previous Lumisys products, complete compatibility is not possible. No warranty of compatibility with previous Lumisys protocols is intended, nor should any be inferred.

1.4 Scope

This document specifies the complete ***Lumiscan LSDT SCSI Compatibility Protocol.*** Each command in the will be described with references to related commands that may be required to perform a complete operation.

1.5 Document Conventions

1.5.1 Numbers

All numbers in the **text** prefixed with the character zero and lower-case 'x' as "0x" are base 16. All numbers in the text without this prefix are decimal numbers. All numbers in **tables** and **figures** are base 16 (hexadecimal) and are not prefixed with "0x".

1.5.2 Byte Ordering

All 16 and 32 bit integers are passed in standard **NETWORK BYTE ORDER**, which is most significant byte (MSB) first. Any exception to this convention will be explicitly noted.

NOTE: This is the first feature that could confuse you. The Intel 80X86 is a Little-Endian processor. This means that the most significant byte in a 32-bit quantity is also the byte with the highest numerical address. In other words, Intel 32-bit integers would be passed LSB-first if given directly to the 8-bit SCSI interface.

1.6 Applicable Documents

LSDT Software Library Reference Guide Manual P/N 0066-022

LSDT API Dynamic Link Library Reference Guide Manual P/N 0068-105

Lumiscan Operator's Reference Manual (Laser scanner) P/N 0061-494

Lumiscan Operator's Reference Manual (CCD scanner) P/N 0069-384

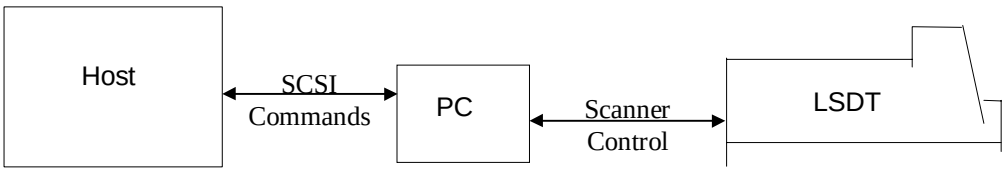
LSDT Internal SCSI Option Operators' Supplement Manual P/N 0070-275

Lumiscan SCSI & ETHERNET Protocol Specification P/N 0059-261

2.0 THEORY OF OPERATION

The LSDT scanners are precision instruments designed to scan film and measure optical density. The transmitted light is collected, converted to an electrical signal and digitized to provide an image with 12-bits-per-pixel of gray scale. The image may then be stored, transmitted electronically, and processed using standard digital image processing techniques.

The LSDT is controlled directly by an 80X86 IBM-PC or compatible computer. The PC can be thought of as the processor component of the embedded controller for the dedicated scanner hardware. The complete embedded controller includes device drivers and support software operate the scanner, and to interface with a **host** computer. For scanners with the Internal SCSI Option, the "PC" component is embedded within the scanner.



A host computer controls the operation of the scanner by sending a series of commands through a communications interface. This document describes commands transmitted through the Small Computer Systems Interface (SCSI). The Lumiscan LSDT SCSI Compatibility Protocol consists of a set of proprietary command definitions to which the scanner responds in the ways specified herein.

The maximum resolution of the LS50 is 128 pixels/inch, or 1024 pixels per line. The maximum resolution of the LS75 is 256 pixels/inch, or 2048 pixels per line. See your scanner manual for the maximum resolution of the particular LSDT scanner in your system.

In variable resolution, the pixels per line are specified, which are distributed evenly over the width of the film. For instance, if 1024 pixels per line were specified, the resolution would be 128 pixels/inch on an 8-inch wide film, and 73 pixels/inch on a 14-inch wide film.

In fixed resolution the pixels per inch are specified. For instance for a 14-inch wide film, the maximum resolution available is 73 pixels/inch. For a film of 8-inches wide or less, the maximum resolution available is 128 pixels/inch. For a film of 14 inches in width, any resolution from 25 to 73 pixels per inch are available. For an 8-inch film, any resolution from 25 to 128 pixels/inch are available.

3.0 COMMAND SET USAGE

From power-up, or re-initialization, send the following recommended commands:

1) Send **TEST UNIT READY** to determine whether the scanner is up, and ready for commands.

2) Send **INQUIRY** to determine which Inquiry response the scanner is using.

3) Send the **WRITE LOOK-UP TABLE** command if the default linear 1:1 LUT is not desired.

To digitize a film and return the data to the host, the following steps are recommended:

1) Send the **SET RESOLUTION** command to set the resolution of the film.

2) Send the **DEFINE WINDOW** command to clip the data that will be returned to the host.

3) Send the **RECEIVE DATA** command, with the First Buffer flag, to start the scanning operation.

4) Send the **RECEIVE DATA** command, with the Continue flag, to return the data to the host. Please note that the scanner will return only the image data within the window defined in the **DEFINE WINDOW** command.
Continue sending **RECEIVE DATA** commands, with the Continue flag until the last data buffer is reached.

5) Send the **RECEIVE DATA** command, with the Last Buffer flag, to read the final block of image data and terminate the scan operation.

For more details see Appendix A - Scanning Example

4.0 DIAGNOSTIC AIDS

When first attempting to interface to the scanner, Lumisys recommends that you attach keyboard and monitor to the PC which controls the scanner. From the keyboard two diagnostic functions can be activated that will capture and display information that can be useful as you develop your interface:

D - (uppercase 'D') activates a dump of scanner commands to the screen.
F - (uppercase 'F') activates a dump of scanner commands and messages to a file called **DEBUG.CMD**.
Note: The 'F' command does not create a file on Internal SCSI machines.

Each function is toggled on and off by repeating its command.

The results will resemble Figure 4-1 below:

Figure 4-1: Sample Debug Output

```
0A 00 00 00 02 00  : 10 00  ; 00
0A 00 00 00 0B 00  : 06 00 00 00 00 36 B0 42 68 09 B7  ; 00
0A 00 00 00 09 00  : 02 01 49 05 C4 01 00 04 91  ; 00

0A 00 00 00 02 00  : 10 01  ; 00
0A 00 00 00 0B 00  : 06 00 00 00 00 18 6A 1E A9 04 7D  ; 00
0A 00 00 00 09 00  : 02 01 49 05 C5 01 00 04 92  ; 00
```

Figure 4-1 shows the commands, data and status in the following format:

6-byte command : data bytes ; status byte

The 6 byte SCSI commands to the scanner are followed by a colon, then the associated data, a semicolon, then the command status which was returned to the host. This dump is useful when trying to determine if your application is sending commands in the form that the scanner will accept. This also verifies that the scanner is receiving what you intended to send.

5.0 SCSI PROTOCOL OVERVIEW

The Lumiscan LSDT SCSI Compatibility Protocol is derived from the Lumisys adaptation of the SCSI-1 protocol. For a full description of the SCSI Protocol the reader should consult ANSI STANDARD X3.131-1986. In addition, there is a much more readable reference titled ***"THE SCSI Bench Reference"*** from:

ENDL Publications
14426 Black Walnut Court
Saratoga, California 95070
(408) 867-6642

5.1 LUMISCAN SCSI Protocol

The following is a brief summary of the SCSI protocol as applied to the **LUMISCAN** products. In the SCSI Protocol, there is an initiator device (HOST COMPUTER) and a Target device (SCANNER, DISK, TAPE, ETC.). Electrically and logically, there are several "PHASES" in a message transaction. They are:

1) **Arbitration Phase** - The hardware negotiates for the SCSI BUS.

2) **Selection Phase** - The Initiator has the bus and Selects the Target.

3) **Command Phase** - Once selected, the Target controls the bus and requests the command bytes from the Initiator. For the **LUMISCAN** 50 SCSI Compatibility Protocol, all the commands are six bytes long. The SCSI specification also defines 10 and 12 byte commands.

4) **Data In Phase** - This phase doesn't exist for some commands. If data is to be transferred to the **LUMISCAN** the data in phase is entered and data is transferred.

5) **Data Out Phase** - This phase doesn't exist for some commands. If data is to be transferred to the HOST, the data out phase is entered and data is transferred.

6) **Status Phase** - All SCSI transactions require a Status Phase in which either a success is indicated by 'GOOD'(0), or failure is indicated by 'CHECK CONDITION' (2). When a CHECK CONDITION is returned, the HOST must return a REQUEST SENSE command, in the next SCSI Transaction, to retrieve the actual error code.

7) **Message In Phase** - The **LUMISCAN** devices ignores the message data. There is more to the Message Phase and you may wish to consult ANSI X3.131-1986 for a full description.

8) **Message Out Phase** - The **LUMISCAN** devices always return 0 in this phase. There is more to the Message Phase and you may wish to consult ANSI X3.131-1986 for a full description.

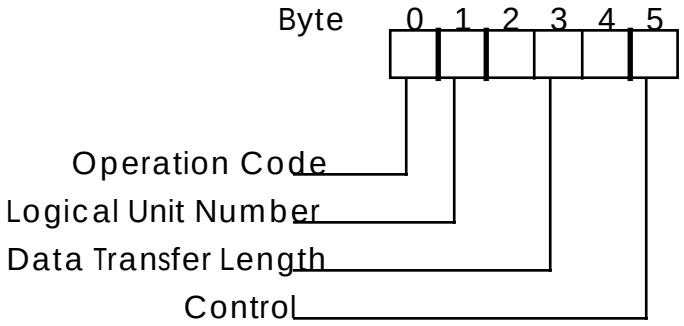
9) **Disconnect** - Once the transaction is complete, the Target disconnects from the bus and waits for the next Selection and Command from the Initiator.

6.0 COMMAND/DATA FORMATS

This sections describes the exact form of each command that the host must send to the **LSDT**. This section also describes the exact form of the data that the host must either send to or receive from the **LSDT.**

6.1 General Format of Commands

The Lumiscan LSDT Compatibility Protocol uses 6-byte commands from the SCSI Group 0:



6.1.1 Operation Code

The Operation Code identifies the command. In the Standard SCSI-1 protocol, the Operation Codes uniquely identify the command. Unfortunately, this is not entirely true of the Lumiscan LSDT Compatibility Protocol. The SCSI-1 Operation Codes 07, 08, and 0xA are *overloaded,* that is, used for more than one command. **The commands using Operation Code 0x0A are uniquely identified by the first word of the data, called the *Send Type*.** All of the commands, and their corresponding Operation Codes are presented below in Table 6-1:

Table 6-1: Lumiscan LSDT Operation Codes

Operation Code	Command Name	Data Transfer Length (Bytes)	Control
00	Test Unit Ready	0	00
03	Request Sense	2	00
07	Calibrate	2000	00
07	Write Look-Up Table	2000	40
07	Read LookUp Table	2000	80
08	Receive Data First Buffer	variable	40
08	Receive Data Continuation Buffer	variable	80
08	Receive Data Last Buffer	variable	C0
09	Digitize	00	00
0A	Program Resolution Flag	02	00
0A	Program Redirection Flag	06	00
0A	Define Window	09	00
0A	Set Resolution	0B	00
0A	Program Redirection Flag and Filename	from 7 to 0F	00
0A	Program Averaging Mode	02	00
0A	Program Byte Swap Mode	02	00
0C	Detect Film Size	00	00
0D	Get File Size	05	00
12	Inquiry	82 or 8A*	00
14	Calibrate Film Length	00	00
15	Clear AutoLoader Status	00	00
16	Feed Film	00	00
17	Eject Film	00	00
18	Read Bar-code	00	00

Note: recall that all of the numbers above are hexadecimal.
* Configuration file (LSDTCNFG.DAT) option.

6.1.2 Logical Unit Number

The Logical Unit Number for all commands is 0.

6.1.3 Data Transfer Length

The Data Transfer Length is a 24-bit number specifying the number of bytes of data transferred during the Data Phase. The direction of the data transfer (Data-In from the scanner to the host, or Data-Out from the host to the scanner) are determined by the Operation Code and the Control.

6.1.4 Control

The Control byte contains two vendor-specific bits. Bits 6 and 7 of the Control Byte are defined by Lumisys as shown in table 6-1.

6.2 Test Unit Ready

COMMAND

Byte	0	1	2	3	4	5
	00	00	00	00	00	00

Byte 0 - Command code for Test Unit Ready
Byte 1 - 0
Byte 2-4 - 0 - no data received
Byte 5 - 0

DATA IN

none

This command is used to poll the scanner and determine it's state, "BUSY" or "READY". When the scanner is scanning, the scanner will return a status of "BUSY" (08) in response to this command. When the scanner is not scanning, the scanner returns a status of "Ready" (00) in response to this command.

6.3 Request Sense

COMMAND

Byte	0	1	2	3	4	5
	03	00	00	00	02	00

Byte 0 - Command code for Request Sense
Byte 1 - 0
Byte 2,3- 0
Byte 4 - # bytes of sense data to receive - 2
Byte 5 - 0

DATA IN

Byte	0	1
	xx	xx

Byte 0 - LSB of status code
Byte 1 - MSB of status code

NOTE

These status bytes have violated the 'Network Byte Order" convention and are returned LSB/MSB.

These codes are defined in the **Appendix B Error Message Codes**.

6.4 Look-Up Table Commands

COMMAND

Byte	0	1	2	3	4	5
	07	00	00	20	00	X0

Byte 0 - Command code for Look-Up Table Commands
Byte 1 - 0
Byte 2-4- # bytes in LookUp table - 8192 (0x2000)
Byte 5 - **0x40 = WRITE LOOKUP TABLE HARDWARE.**
0x80 = READ LOOKUP TABLE HARDWARE.

DATA IN/OUT

Byte 0-8192 - Binary data - 4096 16 bit words sent LSB/MSB.

There are **TWO** forms of this command which are determined by the "vendor" bits in byte 5 of the command.

A note on the scanning process as it relates to LookUp Tables (LUTs) should be interjected here. The LSDT scanners record *optical density*. The optical density is negative brightness. A very dark feature on film corresponds to a high optical density, and a high corresponding pixel value. When the optical density is displayed on a CRT, it resembles the negative of the original film, with dark features on the film appearing light on the CRT, and vice-versa.

The optical density-to-brightness inversion just described can be undone by loading a linear negative LUT with values beginning with 4095 in location 0, and dropping sequentially to 0. On the other hand, the optical density-to-brightness inversion is preserved by loading a linear positive LUT containing values 0,1,2...4095. A linear positive LUT is loaded by default when the LSDT is powered-on.

6.5 Calibrate

COMMAND

Byte	0	1	2	3	4	5
	07	00	00	XX	XX	00

Byte 0 - Command code for Calibrate
Byte 1 - 0
Byte 2-4- variable number of bytes of data received
Byte 5 - 0

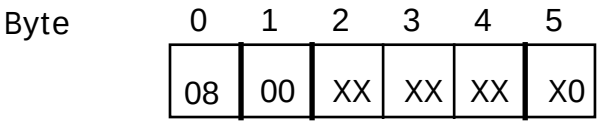
DATA IN

none

The **CALIBRATE** command causes the calibration table to be read. If the Program Redirection Flag = FILM, the calibration data will be returned. If the Redirection Flag is FILE, the LSDT will return UNRECOGNIZED COMMAND.

6.6 Receive Data

COMMAND

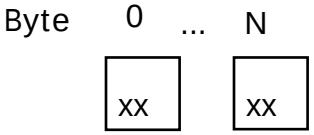


Byte 0 - Command code for Receive Data
Byte 1 - 0
Byte 2-4 - number bytes to transfer in one block.

Byte 5 - Block flag - The upper 2 bits of this byte are 'vendor' bits and have the following meaning.

0x40 - **FIRST** block of a sequence.
0x80 - **CONTINUATION** block in a sequence.
0xC0 - **LAST** block in a sequence.
(At least one of these two bits must be on or the command is rejected.)

DATA IN



Byte 0-XXXX - Data from the LUMISCAN.

This command is used to receive data directly from the scanner either from memory or from the actual scan itself. When the Redirection Flag (defined by the Redirection Flag (and Filename, below) designates FILE, then image data is retrieved from scan memory. When the Redirection Flag designates FILM, then this command is an **implied SCAN** command, which forces scanning to begin immediately. When a scan is initiated using this command, the scanner remains in the "Ready" state, and will respond to commands from the host. In this way, image data may be collected during the scan. The scanner may be polled using the TEST UNIT READY command.
NOTE: The Internal SCSI Option only supports Redirection Flag = FILM

To digitize a film and return data to the host the sequence looks like this:

1. Send the **PROGRAM REDIRECTION FLAG** command to make that the data source is FILM (data byte 1 = 00).

   0A,00,00,00,06,00 : 04,00,00,00,00,00
   (6 bytes of data required.)

2. Send the **RECEIVE DATA** command to retrieve the image data**:**

   08,00,01,FB,98,40 <== 1st buffer
   08,00,01,FB,98,80 <== Continuation buffer
   08,00,01,FB,98,80 <== Continuation buffer
   08,00,01,FB,98,80 <== Continuation buffer
   08,00,01,FB,98,80 <== Continuation buffer
   08,00,01,FB,98,80 <== Continuation buffer
   08,00,01,FB,98,80 <== Continuation buffer
   08,00,01,FB,98,80 <== Continuation buffer
   08,00,01,FB,98,80 <== Continuation buffer
   08,00,01,FB,98,80 <== Continuation buffer
   08,00,01,FB,98,80 <== Continuation buffer
   08,00,01,B7,00,C0 <== Last buffer

File headers are not transferred to the host.

6.7 Digitize

COMMAND

Byte	0	1	2	3	4	5
	09	00	00	00	00	00

Byte 0 - 9 - Command code for Digitize
Byte 1 - 0
Byte 2-4- 0 - no data received
Byte 5 - 0

DATA IN

none

NOTE: The following command sequence is **NOT** recommended for use with the Internal SCSI Option.

This command initiates the scan.
When this command is issued, the scanner will immediately complete the command sequence and return a status, then perform the scan and store the data in memory.

The scanner's behavior subsequent to this command is controlled by the configuration file (LSDTCNFG.DAT) WAIT_FOR_DIGITIZE option which is described in the *LSDT SCSI Installation Manual.* When WAIT_FOR_DIGITIZE is set to "TRUE", this command is analogous to a "blocking read". While the scan is being performed, the scanner will be in the "Blocked" state. The scanner will not receive and respond to additional commands until the scan is complete. A subsequent **RECEIVE DATA** command will return data as soon as the **DIGITIZE** command has completed. When WAIT_FOR_DIGITIZE is set to "FALSE", the scanner will receive and process commands even while the scanner is busy scanning. This allows the host to retrieve image data from the scanner as soon as it is collected.

To digitize a film using this command and then retrieve the image file, the host must:

1) Send the **DIGITIZE** command.

2) Send the **RECEIVE DATA** command to read blocks of data until the desired number of bytes in the file have been received. Please note that this may be calculated only approximately in advance using pixels per line to obtain a pixels per inch value, then performing the following calculation:

   LinesInImage = PixelsPerInch * FilmLengthInInches;
   bytesToTransfer = PixelsPerLine * BytesPerPixel * LinesInImage;

NOTE: The Internal SCSI Option will lose data if the host does NOT read the image data as the film it is being scanned.

The following illustrates how the commands would perform a scan and return data to the host:

09,00,00,00,00,00 <= Send the DIGITIZE command.

[If WAIT_FOR_DIGITIZE is TRUE,
SCANNER UNRESPONSIVE UNTIL SCAN COMPLETION]

0D 00 00 00 05 00 <== GET FILE SIZE
08,00,20,00,00,40 <== RECEIVE 1ST BUFFER
08,00,20,00,00,80 <== RECEIVE Continuation Buffer
08,00,20,00,00,80 <== RECEIVE Continuation Buffer
08,00,20,00,00,80 <== RECEIVE Continuation Buffer
.. ..
08,00,20,00,00,80 <== RECEIVE Continuation Buffer
08,00,20,00,00,80 <== RECEIVE Continuation Buffer
08,00,01,8E,88,C0 <== RECEIVE Last Buffer

If the WAIT_FOR_DIGITIZE option is "TRUE", the host may poll the scanner with any command to determine whether the scan has completed The scanner will not respond until the scan has completed. The GET FILE SIZE command will then return the size of the image collected.
NOTE: WAIT_FOR_DIGITIZE = TRUE will **NOT** work with the Internal SCSI Option

If the WAIT_FOR_DIGITIZE option is FALSE, the host must use Test Unit Ready commands to determine when the scan has completed. Prior to completion of the scan, the GET FILE SIZE data returned will be computed as described above.
NOTE: with the Internal SCSI Option, WAIT_FOR_DIGITIZE = FALSE will **lose** data if the image size exceeds the internal memory buffer size.
***
The host issues RECEIVE commands repeatedly until the scanner has returned the entire image.

6.8 Program Resolution Flag

COMMAND

Byte	0	1	2	3	4	5
	0A	00	00	00	02	00

Byte 0 - Command code for Program Resolution Flag
Byte 1 - 0
Byte 2-4- # bytes in data phase - 2
Byte 5 - 0

DATA OUT

Byte	0	1
	10	0X

Byte 0 - Send Type - PROGRAM RESOLUTION FLAG = 0x10
Byte 1 - Resolution flag = 0, or 1

The command type of this command, and all others is determined by the first byte of the data. The **PROGRAM RESOLUTION FLAG** command uses a send type of 0x10.

The **PROGRAM RESOLUTION FLAG** command performs **NO OPERATION**, and is supplied only for compatibility with previous Lumisys scanners. All subsequent **SET RESOLUTION** commands apply to the Film. **DEFINE WINDOW** commands perform clipping on the image returned using **RECEIVE DATA** commands.

6.9 Program Redirection Flag (and Filename)

COMMAND

Byte	0	1	2	3	4	5
	0A	00	00	00	XX	00

Byte 0 - Command code for Program Redirection Flag and Filename
Byte 1 - 0
Byte 2-4 - # bytes in data phase - 6 (without filename) or n (with filename)
Byte 5 - 0

DATA OUT

Byte	0	1	2	3	4	5		N
	04	0X	00	00	00	0X	...	XX

Byte 0 - Send Type - PROGRAM REDIRECTION FLAG = 0x04

Byte 1 - Redirection flag.
0 = FILM, 1 = FILE
Unfortunately, the meaning of this flag is ambiguous. The meaning is related to the command that will follow. In the case of the **RECEIVE** command, **FLAG=1** means get the data from memory (from a previous scan), **FLAG=0** means get the data from a film (scan now).

Byte 2-4- 0

Byte 5 - # bytes in file name range 0 to n. If there is no file name, this field should be set to 0 and no additional characters sent. The length field in the command body would have to change accordingly. **This is provided for compatibility with previous Lumisys scanners. The LSDT does not store images in files resident on the scanner.**

Byte 6-14 - ASCII code of the characters in the file name

6.10 Define Window

COMMAND

Byte	0	1	2	3	4	5
	0A	00	00	00	09	00

Byte 0 - Command code for Define Window
Byte 1 - 0
Byte 2-4 # bytes in data phase - 9
Byte 5 - 0

DATA OUT

Byte	0	1	2	3	4	5	6	7	8
	02	XX	XX	XX	XX	XX	XX	XX	XX
		Y0		Y1		X0		X1	

Byte 0 - Send Type - DEFINE WINDOW = 0x02

Byte 1,2 - Start y of window in lines. Range depends upon resolution.

Byte 3,4 - End y of window in lines. Range depends upon resolution.

Byte 5,6 - Start x of window in pixels. Range depends upon resolution.

Byte 7,8 - End x of window in pixels. Range depends upon resolution.

Note: The number of pixels in the x direction = EndX - StartX + 1. The number of lines in the window = EndY - StartY + 1. (EndX and EndY are inclusive. Start must be smaller than end, so the minimum window size is 2 by 2.)

This command causes the image that is returned to the host to be clipped to the window dimensions at the resolution set by the SET RESOLUTION command.

6.11 Set Resolution

COMMAND

Byte	0	1	2	3	4	5
	0A	00	00	00	0B	00

Byte 0 - Command code for SET RESOLUTION
Byte 1 - 0
Byte 2-4 - # bytes in data phase - 11 (0x0b)
Byte 5 - 0

DATA OUT

Byte	0	1	2	3	4	5	6	7	8	9	0A
	06	00	00	00	00	XX	XX	XX	XX	XX	XX
		X0		Y0		X1		Y1		Lines/Y	

Note: The **SET RESOLUTION** command will define the film size and resolution. After receiving this command the window will be reset to the same definition as the film size. This command of course also defines the resolution (lines per inch in the y axis, as well as pixels per inch in the x axis).

Byte 0 - Send Type - **SET RESOLUTION** = 0x06

Byte 1,2- Start x of boundary in mils(X0). Always 0.

Byte 3,4- Start y of boundary in mils(Y0). Always 0.

Byte 5,6- Delta x of boundary in mils. Range 2000 to 14000 mils(0x7d0 to 0x36B0).

Byte 7,8- Delta y of boundary in mils. Range 1 to n.

Byte 9,10- Number of lines in the y dimension. Range 1 to n based pixels per line.

This command:

SET_RESOLUTION 0,0,14000,17000,1105

translates to a 14-inch by 17-inch film with 1105 lines in 17-inches for 65 pixels per inch, and 910 pixels per line.

Send the **SET RESOLUTION** command. Then if you want to have a window defined, you need to send the **DEFINE WINDOW** command because it is defined in terms of pixels.

For example, the sequence looks like this:

1. SET RESOLUTION COMMAND

0A,00,00,00,0B,00 : 06,00,00,00,00,17,70,17,70,02,00
X1 Y1 DX DY 512 lines/DY

2. DEFINE WINDOW COMMAND

0A,00,00,00,09,00 : 02,00,00,01,FF,00,00,01,FF
Y1 Y2 X1 X2

6.12. Program Averaging Mode

COMMAND

Byte	0	1	2	3	4	5
	0A	00	00	00	02	00

Byte 0 - Command code for Program Averaging Mode
Byte 1 - 0
Byte 2-4- # bytes in data phase - 2
Byte 5 - 0

DATA OUT

Byte	0	1
	0c	0X

Byte 0 - Send Type - PROGRAM AVERAGING MODE = 0x0C
Byte 1 - Averaging Mode:
0 - no averaging, 1 = X axis, 2 = Y axis or 3 = X & Y axis

The command type of this command, and all others is determined by the first byte of the data. The **PROGRAM AVERAGING MODE** command uses a send type of 0x0C.

6.13. Program Byte Swap Mode

COMMAND

Byte	0	1	2	3	4	5
	0A	00	00	00	02	00

Byte 0 - Command code for Program Byte Swap Mode
Byte 1 - 0
Byte 2-4- # bytes in data phase - 2
Byte 5 - 0

DATA OUT

Byte	0	1
	0e	0X

Byte 0 - Send Type - PROGRAM BYTE SWAP MODE = 0x0E
Byte 1 - Byte Swap Mode:
0 - no swap, LSB first (Intel), 1 - swap, MSB first (Motorola)

The command type of this command, and all others is determined by the first byte of the data. The **PROGRAM BYTE SWAP MODE** command uses a send type of 0x0E.

6.14 Detect Film Size

COMMAND

Byte	0	1	2	3	4	5
	0C	00	00	00	00	00

Byte 0 - Command code for Detect Film Size
Byte 1 - 0
Byte 2-4 - 0 - no data received
Byte 5 - 0

DATA IN

none

This command performs **NO OPERATION**, and is provided only for compatibility with previous Lumisys scanners. The film size returned in the INQUIRY response is 14 inches by 17 inches (14000 mils by 17000 mils) OR the values set by the previous SET_RESOLUTION command.

6.15 Get File Size

COMMAND

Byte	0	1	2	3	4	5
	0D	00	00	00	05	00

Byte 0 - Command code for Get File Size
Byte 1 - 0
Byte 2-4 - # bytes in data phase - 5
Byte 5 - 0

DATA IN

Byte	0	1	2	3	4
	XX	XX	XX	XX	00

Byte 0-3- #bytes in file.

Byte 4 - Header flag. The header is not returned to the host.

If the scanner is busy scanning, this command returns the product of the number of pixels per line, the number of lines per film, and the number of bytes per pixel. If the scan has completed, this command returns the actual number of bytes scanned by the scanner hardware.

No clipping via the DEFINE WINDOW is applied to the "file". If the image is clipped using the DEFINE WINDOW, then the host must perform the revised calculation for the actual bytes to be received.

6.16 Inquiry

COMMAND

Byte	0	1	2	3	4	5
	12	00	00	00	XX	00

Byte 0 - Command code for Inquiry
Byte 1 - 0
Byte 2 - 0 - Page Code (SCSI II) Always 0
Byte 3 - 0 - Reserved
Byte 4 - # bytes in data phase - 130 (0x82) or 138 (0x8A)
Byte 5 - 0

Note: The INQUIRY response has two formats. These formats are selectable by changing the configuration (in configuration file LSDTCNFG.DAT) as described in the *LSDT SCSI Installation Manual*. The two choices are called LUMISYS and ANSI STANDARD.

The LUMISYS format was defined before the ANSI SCSI II Specification was released.

While SCSI II was in the formative process a fixed format for the first 36 bytes was defined. This fixed format is expected by Macintoshes, Suns, and most intelligent SCSI host adapters today. It is recommended that your application adapt to the new format or support both new and old. Using the ANSI Standard format allows devices to be identified by Company Name, Product Name and Software Version Number when the host is booting.

Remember: All 16 & 32 bit INTEGERS are returned to the host in NETWORK BYTE ORDER (MSB,LSB).

DATA IN

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
06	01	01	00	82	00	00	05	B6	04	91	06	E7	00	18	00

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0F	00	02	01	25	05	25	00	92	03	6E	00	00	39	04	4C

32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
00	00	00	00	1F	40	27	10	05	B7	01	00	0X	0X	09	64

48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
3A	64	69	73	2E	69	6D	67	00	XX	XX	XX	XX	XX	XX	XX

64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79

XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95

XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

96 97 98 99 100 1 2 3 4 5 6 7 8 9 10 11

XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

112 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

128 29

00	C8

Byte Offset Definition

0 - 6 = Processor device

1 - Device Type Qualifier

0 = LSDT
0 = LS100
0x10 = LS200
0 = LS150_S
0 = LS150_M

2 - 1 = Conforms to ANSI SCSI-1 specification

3 - 0

4 - 130 = Additional Length (n-4)# bytes of data. The number of data bytes is 130, a hex value of 0x82

5 - 0

6 - 0

7,8 - # lines per frame minus 1. For this example, the value is 1463-1 = 1462, a hex value of 0x05b6.

9,10 - # pixels per line minus 1. For this example, the value is 1170-1 = 1169, a hex value of 0x0491.

11,12- # microsteps per line. For this example, the value is 1767, a hex value of 0x06e7.

13,14- # clocks per pixel. For this example, the value is 24, a hex value of 0x0018.

15,16- # clocks per galvo up. For this example, the value is 15, a hex value of 0x000f.

17,18- # clocks per galvo down. For this example, the value is 2, a hex value of 0x0002.

19,20- Start y of window in lines. For this example, the starting line is 293, a hex value of 0x0125.

21,22- End y of window in lines. For this example, the ending line is 1317, a hex value of 0x0525.

23,24- Start x of window in pixels. For this example, the starting pixel is 146, a hex value of 0x0092.

25,26- End x of window in pixels. For this example, the ending pixel is 878, a hex value of 0x036e.

27 - Headers Flag 0=off, 1=on. (ALWAYS 0 for LSDT)

28,29- # clocks per microstep. For this example, the value is 57, a hex value of 0x0039.

30,31- # clocks per delay to first pixel. For this example, the value is 1100, a hex value of 0x044c.

32,33- Start x of FILM boundary in mils. The starting point of the film boundary is always 0.

34,35- Start y of FILM boundary in mils. The starting point of the film boundary is always 0.

36,37- Delta x of FILM boundary in mils. For this example, the number of inches in the x dimension is 8 which is 8000 mils, a hex value of 0x1f40.

38,39- Delta y of FILM boundary in mils. For this example, the number of inches in the y dimension is 10 which is 10000 mils, a hex value of 0x2710.

40,41- # lines per frame. For this example, the value is 1463, a hex value of 0x05b7.

42- Redirection flag. For this example, the flag is set to redirect data to/from the **LUMISCAN** - 1

43 - LUT Flag, NORMAL=0, INVERTED=1. Version 6.4.20 and 6.5.7 or later software.

44 - Feature 1 present bits: bit set to indicate that the feature is supported the machine.
Bit #0 - X averaging
Bit #1 - Y averaging
Bit #2 - Byte Swap
Bit #3 - Film present sensor
Bits #4-#7 - reserved, zero

45 - Feature 1 status bits: bit set to indicate that the feature is enabled.
Bit #0 - X averaging ON
Bit #1 - Y averaging ON
Bit #2 - Byte Swap ON - MSB first (Motorola)
Bit #3 - Film present

Bits #4-#7 - reserved, zero

46 - # bytes in file name. For this example, the name is "d:dis.img" which is 9 characters.

47-55- ASCII code of the characters in the file name (NOT USED in LSDT)

56-99- Unused.

100-119- Software Version String, Null Terminated.

120-127 - Unused.

128,129 - Spot size in microns. For this example, the value is 200 (0x00c8).

The ANSI STANDARD FORMAT is as follows. Please note, several fields of the old format were considered useless and are not returned in the new format.

Remember: All 16 & 32 bit INTEGERS are returned to the host in NETWORK BYTE ORDER (MSB,LSB).
"char" = 8 bits, "int" = 16 bits

```
typedef struct {
   unsigned char ucDeviceType;              /* Device Type = 6 = Scanner */
   unsigned char ucDeviceTypeQualifier;     /* System ID, LSDT,100,150M/S,200 */
   unsigned char ucVersions;          /* 0=NonANSI, 1=ANSI, 2=ANSI-2 */
   unsigned char ucResponseFormat;          /* 0=SCSI Standard INQ format */

   unsigned char ucAddLength;               /* # of bytes following this field */
   unsigned char ucUnused1[2];              /* reserved */
   unsigned char ucFlags;                   /* 0=doesn't support anything */

   unsigned char ucVendorID[8];             /* LUMISYS */
   unsigned char ucProductID[16];           /* LS200, LS150M, LS150S, LS50, LS75...*/
   unsigned char ucProductRevLevel[4];      /* 6420 = V6.4.20 */

                                            /* (Offset 36) */
   unsigned int uiPixelsPerLine;            /* Pixels Per Line */
   unsigned int uiLinesPerFilm;             /* Lines Per Film */

   unsigned int uiUStepsPerLine;            /* Micro Steps Per Line */
   unsigned int uiClksPerPixel;             /* Clks Per Pixel */
   unsigned int uiClksPerGalvoUp;           /* Clks Per Galvo Up */
   unsigned int uiClksPerGalvoDwn;          /* Clks Per Galvo Down */
   unsigned int uiClksPerUstep;             /* Clks Per Micro Step */
   unsigned int uiClksPerDelay;             /* Clks Per Delay (Delay to 1st Pixel) */
   unsigned int uiPixelSize;                /* Pixel Size in microns e.g. 148 */

unsigned char ucFeature1_present;  /* bit set to indicate that the feature is supported */
                                   /* Bit #0 - X averaging */
                                   /* Bit #1 - Y averaging */
                                   /* Bit #2 - Byte Swap */
                                   /* Bit #3 - Film present sensor */
                                   /* Bits #4-#7 - reserved, zero */
unsigned char ucFeature1_status;          /* bit set to indicate that the feature is enabled */
                                   /* Bit #0 - X averaging ON */
                                   /* Bit #1 - Y averaging ON */
                                   /* Bit #2 - Byte Swap ON - MSB first (Motorola) */
                                   /* Bit #3 - Film present */
                                   /* Bits #4-#7 - reserved, zero */
```

```
    unsigned char ucReserved[40];               /* (Offset 56) */

                                                /* (Offset 96) */
    unsigned int uiWinStartY;                   /* Starting Y of Window in Lines */
    unsigned int uiWinEndY;                     /* Ending Y of Window in Lines */
    unsigned int uiWinStartX;                   /* Starting X of Window in Pixels */
    unsigned int uiWinEndX;                     /* Ending X of Window in Pixels */

                                                /* (Offset 104) */
    unsigned int uiFilmStartX;          /* in milli inches, always 0 */
    unsigned int uiFilmStartY;          /* in milli inches, always 0 */
    unsigned int uiFilmDeltaX;                  /* in mils*/
    unsigned int uiFilmDeltaY;                  /* in mils*/

                                                /* (Offset 112) */
    unsigned char ucRedirectionFlag;            /* 0=To Host, 1=To Lumiscan */
    unsigned char ucHeaderFlag;                 /* 0=off, 1=Lumisys Header, 2=SUN VFF */
    unsigned char ucLutFlag;                    /* NORMAL=0, REVERSE=1 */
    unsigned char ucUnused3;                    /* unused, pad to even byte boundary */

                                                /* (Offset 116) */
    unsigned char ucSWVersion[20];  /* V6.4.20C Beta... */

                                                /* (Offset 136) */
    unsigned int uiNumStageStop;                /* number of stage stop */
} INQUIRY_RSP;
```

6.17 Calibrate Film Length

COMMAND

Byte	0	1	2	3	4	5
	14	00	00	00	00	00

Byte 0 - Command code for Calibrate Film Length
Byte 1 - 0
Byte 2-4- 0
Byte 5 - 0

DATA IN

none

The **CALIBRATE FILM LENGTH** command causes **NO OPERATION** to be performed. It is supplied only for compatibility with previous Lumisys scanners.

6.18 Clear AutoLoader Status

COMMAND

Byte	0	1	2	3	4	5
	15	00	00	00	00	00

Byte 0 - Command code for Clear AutoLoader Status
Byte 1 - 0
Byte 2-4 - 0
Byte 5 - 0

DATA IN

none

The **CLEAR AUTOLOADER STATUS** command causes **NO OPERATION** to be performed. It is supplied only for compatibility with previous Lumisys scanners.

6.19 Feed Film

COMMAND

Byte	0	1	2	3	4	5
	16	00	00	00	00	00

Byte 0 - Command code for Feed Film
Byte 1 - 0
Byte 2-4 - 0
Byte 5 - 0

DATA IN

none

The **FEED FILM** command causes the optional film feeder to drop a film. If the optional film feeder is not attached, no operation is performed.

6.20 Eject Film

COMMAND

Byte	0	1	2	3	4	5
	17	00	00	00	00	00

Byte 0 - Command code for Eject Film
Byte 1 - 0
Byte 2-4- 0 - no data received
Byte 5 - 0

DATA IN

none

The **EJECT FILM** command causes the LSDT to perform an eject film sequence.

6.21 Read Bar-code

COMMAND

Byte	0	1	2	3	4	5
	18	00	00	00	4F	00

Byte 0 - Command code for Read Bar-code
Byte 1 - 0
Byte 2-4- 4F (79 decimal) (Space allocated by the host to receive the bar-code data.)
Byte 5 - 0

DATA IN

Byte	0			...	0x12
	'B'	'A'	'R'	...	00

Byte 0 - 18 - Bar-code Data from the LUMISCAN.

This command returns the following NULL-terminated string:

BARCODE NOT PRESENT

APPENDIX A - SCANNING EXAMPLE

The following is a simple example of programming the LSDT SCSI scanner to scan one film. This sequence does not assume the state of the scanner. It may be possible to eliminate some of these commands in some situations. However since 99.9% of the time is spent receiving data and savings from removing unnecessary commands will not be worth the possible problems.

```
        SCSI Command      :    Data In or Out                          ; Status code
         03 00 00 00 06 00 : 00 00 00 00 00 00                                ; 00
Send "Request Sense" to check for errors, "00" is no errors

        12 00 00 00 8A 00 : 06 01 01 00 86 00 00 00 4C 55 4D 49 53 59 53
                            20 4C 53 37 35 00 20 20 20 20 20 20 20 20 20
                            20 00 31 2E 35 20 08 00 09 B7 00 00 00 70 00
                            00 00 00 00 00 01 40 01 5E 07 00 00 00 00 00
                            00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
                            00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
                            00 00 00 00 00 00 00 00 09 B5 00 00 07 FF 00
                            00 00 00 36 B0 42 68 00 00 00 01 56 31 2E 35 ; 00
Send "Inquiry" to determine current scanner parameters. This data shows the
Pixels per line set to 1024.

        0A 00 00 00 02 00 : 10 00 ; 00
Send "Program Resolution Flag" to set resolution to "film"

        0A 00 00 00 0B 00 : 06 00 00 00 00 36 B0 42 68 04 DB ; 00
Send "Set Resolution", Start X=0, Start Y=0, delta X=14000 mils,
                   delta Y=17000 mils, Number of Lines=1243.
Notice that the resolution is specified by the Number of Lines across the delta Y
film size. On LSDT scanners pixels are always square, so pixels per line is
always directly related to lines per inch and the film size.
So 1243 lines in 17 inches gives you 1024 pixels in 14 inches.

        0A 00 00 00 09 00 : 02 00 00 04 DA 00 00 03 FF ; 00
Send "Define Window", Start Y=0, End Y=1242, Start X-0, End X=1023
     remember Pixels per line = EndX - StartX + 1
              Lines per image = EndY - StartY + 1

12 00 00 00 8A 00 : 06 01 01 00 86 00 00 00 4C 55 4D 49 53 59 53
                            20 4C 53 37 35 00 20 20 20 20 20 20 20 20 20
                            20 00 31 2E 35 20 04 00 04 DB 00 00 00 70 00
                            00 00 00 00 00 01 40 01 5E 07 00 00 00 00 00
                            00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
                            00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
                            00 00 00 00 00 00 00 00 04 DA 00 00 03 FF 00
                            00 00 00 36 B0 42 68 00 00 00 01 56 31 2E 35 ; 00
Send "Inquiry" to make sure the scanner parameters set correctly, sometimes
because of rounding errors or scanner limitations you don't get exactly what you
want. This data shows the Pixels per line changed to 1024 and the number of lines
set to 1242.

        0A 00 00 00 06 00 : 04 00 00 00 00 00 ; 00
Send "Program Redirection Flag", 0=FILM, no filename
```

```
                SCSI Command      :    Data In or Out                          ; Status code
        08 00 00 80 00 40 : 04 00 00 00 00 00 00 00 4C 55 4D 49 53 59 53 ; 08
```

Send “Receive Data”, count=32768 bytes, FIRST BLOCK (last cmd code byte=x40)
NOTE: Status Code = 8 (Hardware busy)
This commands starts the SCAN. Since the scan is just starting there is no data ready to be returned, so the status is busy. The BUSY status is only returned if the scanner configuration (LSDTCNFG.DAT) specifies “WAIT_FOR_DIGITIZE” as FALSE. If WAIT_FOR_DIGITIZE where TRUE then the “Receive Data” command would not return until there was scan data.

The HOST continues to send “Receive Data” commands until the status is NOT busy

```
                SCSI Command      :    Data In or Out                          ; Status code
        08 00 00 80 00 40 : 04 00 00 00 00 00 00 00 4C 55 4D 49 53 59 53 ; 08
          ..  ..              ..     ..              ..      ..
        08 00 00 80 00 40 : 04 00 00 00 00 00 00 00 4C 55 4D 49 53 59 53 ; 08
        08 00 00 80 00 40 : 04 00 00 00 00 00 00 00 4C 55 4D 49 53 59 53 ; 08
        08 00 00 80 00 40 : 04 00 00 00 00 00 00 00 4C 55 4D 49 53 59 53 ; 00
```

This commands status code is OK (00), so the first part of the scan data has been returned. Now the “BLOCK Flag” (last cmd code byte) changes from x40 to x80 = CONTINUATION. The HOST sends CONTINUATION type “Receive Data” commands until all the image data has been read.

```
        08 00 00 80 00 80 : 04 00 00 00 00 00 00 00 4C 55 4D 49 53 59 53 ; 00
        08 00 00 80 00 80 : 04 00 00 00 00 00 00 00 4C 55 4D 49 53 59 53 ; 00
        08 00 00 80 00 80 : 04 00 00 00 00 00 00 00 4C 55 4D 49 53 59 53 ; 00
          ..  ..              ..     ..              ..      ..
        08 00 00 80 00 80 : 04 00 00 00 00 00 00 00 4C 55 4D 49 53 59 53 ; 00
        08 00 00 80 00 80 : 04 00 00 00 00 00 00 00 4C 55 4D 49 53 59 53 ; 00
        08 00 00 80 00 80 : 08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ; 00
        08 00 00 80 00 80 : 08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ; 08
        08 00 00 80 00 80 : 08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ; 08
        08 00 00 80 00 80 : 08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ; 08
        08 00 00 80 00 80 : 08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ; 08
```

The Status code changed to BUSY after the end of the film was reached. Because the HOST is trying to read a total byte count = (Pixels per Line * Lines * 2) the HOST my read more data then there is film. This is NOT an error. After the end of the film the HOST may continue to read. The scanner returns zero filled buffers. There is a short period of time while the scanner is ejecting the film when it reports BUSY, but soon the zero filled data is returned.

```
        08 00 00 80 00 80 : 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ; 00
        08 00 00 80 00 80 : 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ; 00
        08 00 00 58 00 C0 : 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 ; 00
```

The last HOST data read uses a “Receive Data” command with the Block Flag set to LAST Block (xC0).

```
                SCSI Command      :    Data In or Out                          ; Status code
        12 00 00 00 8A 00 : 06 01 01 00 86 00 00 00 4C 55 4D 49 53 59 53
                            20 4C 53 37 35 00 20 20 20 20 20 20 20 20 20
                            20 00 31 2E 35 20 04 00 04 4F 00 00 00 A2 00
                            00 00 00 00 00 01 40 01 5E 07 00 00 00 00 00
                            00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
                            00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
                            00 00 00 00 00 00 00 00 04 4E 00 00 03 FF 00
                            00 00 00 36 B0 42 68 00 00 00 01 56 31 2E 35 ; 00
```

Send “Inquiry”. This data shows the Pixels per line set to 1024 and the number of lines set to 1102. Since when the scan was started the number of lines was set to 1242, this shows that the film was shorter then we expected, this is not

uncommon.

18 00 00 00 4F 00 : 4E 4F 20 42 41 52 43 4F 44 45 20 50 52 45 53 ; 00
Send “Read Bar-code” and receive the ASCII string “NO BARCODE PRESENT”. Currently the LSDT scanners do not have barcode readers so this is always the response. There may be barcode readers in the future. The read barcode command should be sent after the scan. If there were a barcode reader it would read during the scan.

APPENDIX B - GLOSSARY

LSDT	**LUMISCAN DeskTop**
LS50	**LUMISCAN 50**
LS75	**LUMISCAN 75**
LS100	**LUMISCAN 100**
LS150	**LUMISCAN 150**
LS200	**LUMISCAN 200**
Host	The computer that controls the **LUMISCAN**. It can be DEC, NeXT, Apple, SUN, etc.
SCSI	Small Computer Systems' Interface

APPENDIX C - ERROR MESSAGE CODES

File name: errors.h

Description: list of all error codes returned by Lumisys LSDT SCSI scanners
NOTE: see the "errors.h" file for a list of all possible Lumisys error codes, the following is only a list of the errors that might be returned by a LSDT SCSI system.

```
#define ALL_OK                                  0
#define PIC_OK                                  ALL_OK

#define SPOTSIZE_TOO_BIG                        5
#define SPOTSIZE_TOO_SMALL                      6
#define UNRECOGNIZED_COMMAND                    23
#define FUNC_NOT_IMPLEMENTED                    38
#define BAD_PARAMETER                           41
#define DIS_DIGITIZE_TIMEOUT                    203
#define DIS_ILLEGAL_EXIT                        205
#define DIS_CANT_FIND_SIDE                      212
#define HOST_SCSI_DATASIZE                      603
                                                /* 1000-1050++    LSDTFCNS.LIB */

#define LSDTFCNS_NO_ERROR                       0
#define LSDTFCNS_FIRST_ERROR_CODE               1001
#define LSDTFCNS_ILLEGAL_BUFFER_SIZE            1001
#define LSDTFCNS_ILLEGAL_DRIVER_FCN             1002
#define LSDTFCNS_ILLEGAL_PIX_PER_LINE           1003
#define LSDTFCNS_ILLEGAL_SCAN_MODE              1004
#define LSDTFCNS_ILLEGAL_BITS_PER_PIXEL         1005
#define LSDTFCNS_ILLEGAL_PIXEL_FORMAT           1006
#define LSDTFCNS_ILLEGAL_BYTES_TO_READ          1007
#define LSDTFCNS_HARDWARE_BUSY                  1008
#define LSDTFCNS_DETECT_FILM_BUSY               1009
#define LSDTFCNS_DETECT_FILM_ERROR              1010
#define LSDTFCNS_NOT_ENOUGH_DATA                1011
#define LSDTFCNS_END_OF_IMAGE                   1012   /* end of image */
#define LSDTFCNS_LUT_OUT_OF_RANGE               1013
#define LSDTFCNS_CAL_TABLE_OUT_OF_RANGE         1014
#define LSDTFCNS_ILLEGAL_CAL_TABLE              1015
#define LSDTFCNS_CAL_LUT_OUT_OF_RANGE           1016
#define LSDTFCNS_ILLEGAL_CAL_LUT_TABLE          1017
#define LSDTFCNS_TEST_CAL_LUT_ERROR             1018
#define LSDTFCNS_TEST_DCB_MEM_ERROR             1019
#define LSDTFCNS_ILLEGAL_TEST                   1020
#define LSDTFCNS_HARDWARE_FAILURE               1021
#define LSDTFCNS_SCAN_ABORTED_ERROR             1022   /* Operator ABORT */
#define LSDTFCNS_CLUT_FILE_ERROR                1023
#define LSDTFCNS_INVALID_PARAMETER              1024
#define LSDTFCNS_DRIVER_NOT_INSTALLED           1025

#define LSDTFCNS_ILLEGAL_AVERAGING_MODE         1026
#define LSDTFCNS_ILLEGAL_BYTES_TO_WRITE         1027
#define LSDTFCNS_DATA_LOST                      1028
#define LSDTFCNS_LOADING_BEYOND_LUT_TABLE       1029
#define LSDTFCNS_MULTIPLE_FILE_MATCHES          1030
#define LSDTFCNS_BAD_FILE_PATHNAME              1031
```

```
#define LSDTFCNS_OPEN_FILE_ERROR                    1032
#define LSDTFCNS_READ_FILE_ERROR                    1033
#define LSDTFCNS_CLOSE_FILE_ERROR                   1034
#define LSDTFCNS_ILLEGAL_PARAMETER                  1035
#define LSDTFCNS_LUT_HARDWARE_FAILURE               1036
#define LSDTFCNS_CYL_EDGE_DET_THRES_ERR             1037
#define LSDTFCNS_CYL_EDGE_DET_MAX_PIX_ERR           1038
#define LSDTFCNS_FILM_EDGE_DET_BAD_OFFSET           1039
#define LSDTFCNS_FILM_EDGE_DET_NO_FILM              1040
#define LSDTFCNS_FILM_EDGE_DET_BAD_FILM             1041
#define LSDTFCNS_FILM_EDGE_DET_BAD_LIMITS           1042
#define LSDTFCNS_SPECIAL_FCNS_DISABLED              1043
#define LSDTFCNS_FILM_EDGE_DET_BAD_EDGES            1044
#define LSDTFCNS_ILLEGAL_PIX_PER_INCH               1045
#define LSDTFCNS_FIX_RES_ERROR                      1046
#define LSDTFCNS_LUT_FILE_SIZE_ERROR                1047

#define LSDTFCNS_LAST_ERROR_CODE          LSDTFCNS_ LUT_FILE_SIZE_ERROR
```